Item 6. Calibration Heads and Gradients

Groundwater flow and contaminant migration are, under most circumstances, determined or influenced by hydraulic gradients. A groundwater model developed to predict the transport and fate of contaminants from a release area should present reasonable correspondence with hydraulic gradients determined using site-specific measurements, to provide confidence it will reasonably predict contaminant transport.

Hydraulic gradients determined from measured data are flat in and around Red Hill. On most occasions, gradients are to the southwest at a low slope, but occasionally they appear to be to the north-northeast. The interim model does not reproduce the magnitude or direction of these gradients: flow in the calibrated model is dominantly Mauka-to-Makai, and most sensitivity-derived alternative models show bias for flow toward Red Hill shaft at gradients that are 10 to 100 times higher than measured values. Although the sensitivity analyses present a range of simulated gradients, the distribution of simulated gradients across all models does not reflect values derived from the synoptic data (Inset Figure 6.1).

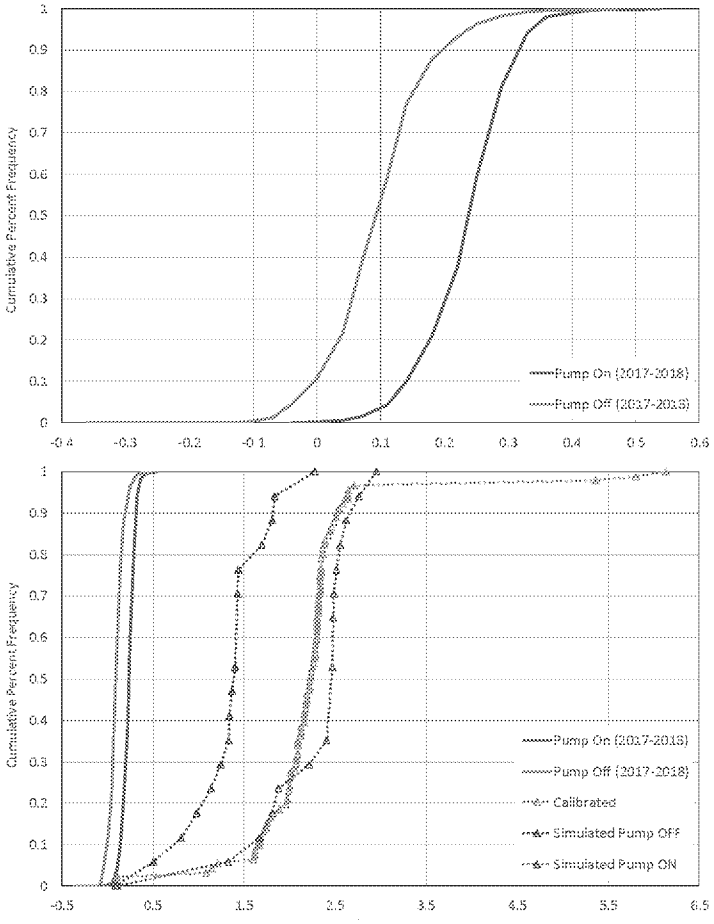

Figure 6.1 Example Comparison of Pairwise Head Differences from Synoptic Data with Simulate Head Differences from All Interim Models

Historical data have had sufficient shortcomings (frequency, reference elevations, lack of pumping knowledge) that they were not amenable to rigorous analysis. Recent synoptic data provide improved frequency and quality. These data suggest that certain aspects of the CSM incorporated into the interim flow model may prevent the model from reproducing these gradients, including the saprolite; basalt strike and dip; the "keying" of saprolites down-valley into Honolulu volcanics, older sediments and cap rock; and recharge distribution and rates.

The final CSM and model should focus on analyzing recent synoptic data to the extent possible, and down-weight analyses based on older data. Despite difficulties preparing water level maps, pairwise head-difference plots can show the effects of pumping on gradients and the frequency and magnitude of gradient reversals. Steady-state model calibration should focus on demonstrating a match with regional patterns and with representative local gradients under pumping and non-pumping conditions. This combination is required to demonstrate that the model is useful for near-field transport to

understand the available groundwater data, and for developing predictions of capture zones for Red Hill shaft and Halawa shaft to help evaluate risk and mitigating responses or strategies. Transient calibration will provide information on T, S, anisotropy, and possibly on the geometry of features such as the saprolite, but is not a substitute for obtaining reasonable mean-centered correspondence to the measured gradients (or pairwise head differences).